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Evaluation of Magnetic Resonance Imaging/Ultrasound-Fusion Biopsy in Patients with Low-Risk Prostate Cancer Under Active Surveillance Undergoing Surveillance Biopsy

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Keywords

Magnetic resonance imaging/ultrasound-fusion biopsy · Low-risk prostate cancer · Multiparametric magnetic resonance imaging · Systematic biopsy · Active surveillance

Abstract

Introduction: Targeted biopsy of tumour-suspicious lesions detected in multiparametric magnetic resonance imaging (mpMRI) plays an increasing role in the active surveillance (AS) of patients with low-risk prostate cancer (PCa). The aim of this study was to compare MRI/ultrasound-fusion biopsy (fusPbx) with systematic biopsy (sysPbx) in patients undergoing biopsy for AS. ***Methods:*** Patients undergoing mpMRI and transperineal fusPbx combined with transrectal sysPbx (comPbx) as surveillance biopsy were investigated. The detection of Gleason score upgrading and reclassification according to Prostate Cancer Research International Active Surveillance criteria were evaluated. ***Results:*** Eighty-three patients were enrolled. PCa upgrading was detected in 39% by fusPbx and in 37% by sysPbx (p = 1.0). The percentage of patients who were reclassified in fusPbx and sysPbx (p = 0.45) were 64 and 59% respectively. ComPbx detected more frequently tumour upgrading than fusPbx (71 vs. 64%, p = 0.016) and sysPbx (71 vs. 59%, p < 0.001) and more patients had to be reclassified after comPbx than after fusPbx or sysPbx alone. ***Conclusions:*** The combination of fusPbx and sysPbx outperforms both modalities alone with regard to the detection of upgrading and reclassification in patients under AS. Because a high missing rate of significant PCa still exists in both biopsy modalities, a combination of fusPbx and sysPbx should be recommended in these patients.

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Introduction

Active surveillance (AS) has been widely accepted as a treatment strategy in patients with low-risk prostate cancer (PCa) [1–3]. It intends to reduce overtreatment and to defer treatment by surgery or radiotherapy until the time of progression. However, definitions of AS criteria are still heterogeneous and long-term follow-up data are pending [2]. Moreover, the rate of reclassification with consecutive conversion to active treatment in surveillance biopsy during the follow-up is considerable [4]. In the Prostate Cancer Research International Active Surveillance (PRIAS) study, 28% of patients were reclassified at surveillance biopsy after a median follow-up of 1.6 years [1]. Therefore, detection and accurate assessment of tumour aggressiveness are essential to correctly identify patients with low-risk PCa and to avoid misclassification and potentially harmful postponement of active treatment.

Multiparametric magnetic resonance imaging (mpMRI) of the prostate enables better tumour visualization and therefore has become an important method for diagnosing PCa using targeted biopsy [5–9]. Targeted biopsy like MRI-ultrasound-fusion biopsy (fusPbx) has a higher detection rate especially for high-grade PCa compared to conventional random biopsy [6, 7, 9]. Previous studies have reported a better prediction in tumour aggressiveness in the primary biopsy and a lower rate of tumour reclassification in the follow-up in patients with low-risk PCa if the initial biopsy was performed by the combination with fusPbx [10, 11]. Furthermore, it has been shown that mpMRI and consecutive targeted biopsy during AS protocols enhance the identification of AS patients requiring definitive treatment [12]. Thus, mpMRI combined with fusPbx presents a promising method for surveillance biopsy in patients undergoing AS. As a consequence, contemporary guidelines recommend mpMRI in patients with low-risk PCa before AS [13, 14].

The aim of this study was to evaluate the value of mpMRI and transperineal fusPbx in patients with low-risk PCa undergoing surveillance biopsy in an AS protocol compared to transrectal systematic prostate biopsy (sysPbx) and to the combination of both biopsy modalities (comPbx).

Patients and Methods

Recruitment

In this retrospective diagnostic study, patients with proven low-risk PCa undergoing surveillance biopsy in the frame of an AS protocol were enrolled. This study was approved by the Institutional Review Board of the Technical University of Dresden (Vote: EK53022014).

For the surveillance biopsy, all patients underwent transperineal fusPbx combined with transrectal sysPbx.

Primary endpoints were the proportion of patients diagnosed with histological tumour progression defined as the evidence of PCa with Gleason patterns of 4–5 and the proportion of reclassification to clinically significant PCa according to PRIAS criteria in at least one biopsy modality. Criteria for clinically insignificant PCa according to PRIAS were ≤cT2c, ≤2 cores with proven cancer, Gleason score ≤6 (3 + 3), prostate specific antigen (PSA) density <0.2 ng/mL^2 and PSA <10 ng/mL.

MRI Investigations

Patients underwent mpMRI at the department of Radiology at University Hospital Dresden or in ambulatory radiology offices. At the department of Radiology, mpMRI of the prostate were performed on a 3 Tesla MR system (Magnetom Verio, Siemens Medical Solutions, Erlangen, Germany) without endorectal-coil. The mpMRI protocol included T2-weighted images in transverse and coronal orientation, T1-weighted images, diffusion-weighted images, dynamic contrast-enhanced imaging and contrast-enhanced T1-weighted images with fat suppression in transverse orientation. Total MRI acquisition time was 25 min. MpMRIs performed in ambulatory radiology offices were included in further analysis, if at least 2 MRI sequences were available.

The evaluation of the mpMRI was performed by uro-radiologists with an experience of >15 years in evaluating prostate MRI.

The prostate imaging and data system (PI-RADS) v1 and v2 classifications based on criteria of the European Society of Urogenital Radiology [15–17] were used to evaluate tumour-suspicious lesions. The definition of lesions in PI-RADS v1 and v2 was as follows: PI-RADS 1: very low (clinically significant PCa is highly unlikely); PI-RADS 2: low (clinically significant PCa is unlikely); PI-RADS 3: intermediate (clinically significant PCa is equivocal); PI-RADS 4: high (clinically significant PCa is likely); PI-RADS 5: very high (clinically significant PCa is highly likely). When mpMRI was performed in ambulatory radiology offices, the mpMRI was re-evaluated by the in-house radiologists. The maximum PI-RADS (maxPI-RADS) in mpMRI was defined as the lesion with the highest PI-RADS of all lesions per patient. The influence of the maxPI-RADS for the biopsy results in fusPbx, sysPbx and in the combination of both was investigated. Furthermore, all lesions detected in mpMRI were evaluated regarding the tumour detection rate and Gleason Score (GS). Lesions classified as PI-RADS 2 and PI-RADS 3 were evaluated for tumour detection, if these lesions existed alone or beside other lesions classified with a higher PI-RADS.

Prostate Biopsy

The BioJet-System (Fa. d&k technologies, Barum, Germany) was used for transperineal fusPbx. The combination of transperineal fusPbx and transrectal sysPbx was performed as previously described [18]. Targeted biopsy was performed via a transperineal approach while taking at least 2 cores per lesion depending on the size of the lesion. Lesions classified as PI-RADS ≥2 were biopsied. Subsequently in the same session, every patient underwent a 12-core sysPbx transrectally. In sysPbx, the needle was placed according to a scheme covering 12 regions of the prostate (medial and lateral apex, medial and lateral mid prostate and medial and lateral base in both lobes). SysPbx was completed by the same urologist who had performed the targeted biopsy.

Table 1. Patients' demographics (n = 83), findings on mpMRI and histopathology of prostate biopsy cores

Parameter	Value
Age, years, median (IQR)	67 (63–72)
PSA, ng/mL, median (IQR)	6.9 (5.5–9.3)
Suspicious findings in DRE, *n* (%)	6 (7.2)
Prostate volume, mL, median (IQR)	44 (32–63)
PSA density, ng/mL^2, median (IQR)	0.12 (0.05–0.25)
Overall biopsy cores per patient, *n*, median (IQR)	18 (16–21)
Targeted biopsy cores per patient, *n,* median (IQR)	6 (4–8)
Systematic biopsy cores per patient, *n*, median (IQR)	12 (12–12)
Ratio of positive cores to total cores in targeted biopsy per patient, %, mean ± SEM	29±4
Cancer core involvement in targeted biopsy, mm, mean ± SD	3.7±3.5
Ratio of positive cores to total cores in systematic biopsy per patient, %, mean ± SEM	18±2
Cancer core involvement in systematic biopsy, mm, mean ± SD	1.9±1.6
Number of lesions/patient, *n*, median (IQR)	1 (1–2)
MRI (n) before prostate biopsy	
Total number of lesions	153
Number of lesions evaluated according to PI-RADS	114
PI-RADS of lesion, *n*	
2	21
3	37
4	33
5	23
PI-RADSmax in investigated patients, *n*	
No PI-RADS indicated	31
2	4
3	20
4	15
5	13
Histological findings (n) in combined prostate biopsy	
Gleason Score of biopsy (combination of targeted and systematic biopsy, *n*	
No tumour	18
3 + 3 = 6	25
3 + 4 = 7	26
4 + 3 = 7	7
≥8	7

All biopsy specimens were investigated at the Department of Pathology of the University Hospital Dresden. The biopsy cores were paraffin embedded. Five step sections were cut at 2 µm and stained with haematoxylin-eosin and microscopically examined. We defined a GS ≥7 (3 + 4) as significant PCa.

Analysis of detection rates in lesions detected in mpMRI was performed based on patient characteristics (maxPI-RADS) and on lesion characteristics; this analysis includes the analysis of all lesions detected by mpMRI.

Statistical Analysis

Data were analysed using SPSS version 23.0 (IBM Corp., Armonk, NY, USA). Categorical variables were presented by absolute and relative frequencies. Continuous variables were described by means, complemented by median and range. Student t test and χ^2 test were applied to determine differences between numerical and categorical variables. The McNemar-test was used to compare the detection rate of fusPbx to sysPbx and comPbx. A p value of <0.05 was considered statistically significant. Uni- and multivariate logistic regression analyses were used to evaluate the reclassification to clinically significant PCa according to PRIAS criteria.

Results

Detection and Reclassification Rates in MRI/Ultrasound-Fusion Biopsy and Systematic Biopsy

Eighty-three patients with low-risk PCa undergoing surveillance biopsy by fusPbx in combination with sysPbx were included. Low-risk PCa was diagnosed either by sysPbx alone (n = 69) or by fusPbx in combination with sysPbx (n = 14). Patients' characteristics are depicted in Table 1.

Table 2. Biopsy-proven prostate cancer with Gleason score (GS) in MRI/ultrasound-fusion biopsy (fusPbx; $n = 46$) and systematic biopsy (sysPbx; $n = 72$); dark-grey – concordance, red – clinically significant upgrading, light-grey – insignificant upgrading or change in GS

	sysPbx				
	no tumour	GS 6	GS 3 + 4 = 7	GS 4 + 3 = 7	GS ≥8
fusPbx					
No tumour	18	12	3	2	2
GS 6	6	5	1	2	0
GS 3 + 4 = 7	5	3	10	3	1
GS 4 + 3 = 7	1	0	2	1	2
GS ≥8	1	0	0	2	1

In the combination of both biopsy modalities, PCa detection rate was 78% (65/83), whereby tumour progression to a GS ≥7 (3 + 4) was detected in 48% (40/83). Reclassification according to PRIAS criteria occurred in 71% (59/83) of patients. SysPbx detected more PCa of any Gleason grade than fusPbx (63% [52/83] vs. 55% (46/83); $p = 0.377$). FusPbx detected progression to clinically significant PCa (GS ≥7 [3 + 4]) as frequently as sysPbx (39% [32/83] vs. 37% [31/83]; $p = 1.0$). In fusPbx alone, 64% (53/83) would be reclassified according to PRIAS criteria compared to 59% (49/83) in sysPbx alone ($p = 0.454$).

Regarding missing rates, fusPbx alone would have missed 23% of significant PCa (9/40), whereas sysPbx alone would have missed 25% of significant PCa (10/40; Table 2).

The combination of both biopsy modalities found more frequently PCa than fusPbx (78% [65/83] vs. 55% [46/83], $p < 0.005$) and more than sysPbx alone (78% [65/83] vs. 63% [52/83], $p < 0.005$). Moreover, comPbx detected more frequently tumour progression to clinically significant PCa to Gleason score ≥7 (3 + 4) than fusPbx (48% [40/83] vs. 39% [32/83], $p = 0.008$) and sysPbx alone (48% [40/83] vs. 37% [31/83], $p = 0.012$). Reclassification according to PRIAS occurred more frequently in comPbx than in each modality alone (72% in comPbx vs. 64% in fusPbx [$p = 0.016$] and vs. 59% in sysPbx [$p = 0.001$]).

Detection and Reclassification Rates in Patients with Initial MRI/Ultrasound-Fusion Biopsy in Combination with Systematic Biopsy

Furthermore, we investigated patients with low-risk PCa who were diagnosed by initial fusPbx in combination with sysPbx ($n = 14$). Six out of 14 (43%) of these patients showed tumour progression to a GS ≥7 (3 + 4) and 52% (8/14) were reclassified according to PRIAS. Patients with fusPbx did not show a lower rate of tumour progression than patients with solely sysPbx in surveillance biopsy (both 28%). Table 3 described changes in mpMRI and evidence of clinical and histopathological progression at the time of surveillance biopsy compared to initial biopsy. Three patients with tumour progression presented progression in mpMRI (size or grade of suspicion) performed before surveillance biopsy.

Detection Rate in Lesions Detected by mpMRI

In total, 153 lesions were detected. If lesions were not classified according to PI-RADS initially, PI-RADS was not used later in the re-evaluation by the in-house radiologist. In 31 patients, mpMRI was not evaluated according to PI-RADS due to missed initial classification in ambulatory radiology offices or missed sequences impeding the application of PI-RADS. So, PI-RADS was applied in 52 patients. Thus, 39 lesions (26%) were not investigated according to PI-RADS. One hundred fourteen lesions were evaluated according to PI-RADS (PI-RADS 2: $n = 21$, PI-RADS 3: $n = 37$, PI-RADS 4: $n = 33$, PI-RADS 5: $n = 23$). PCa with a GS ≥7 (3 + 4) was detected in 19% ($n = 4$), 21% ($n = 8$), 18% ($n = 6$) and 57% ($n = 13$) in lesions classified as PI-RADS 2, 3, 4, and 5, respectively.

Regarding the maxPI-RADS presented by the lesion with the highest PI-RADS per patient ($n = 52$), 8% ($n = 4$), 38% ($n = 20$), 29% ($n = 15$) and 25% ($n = 13$) patients presented a maxPI-RADS of 2, 3, 4, and 5, respectively. Figure 1 represents the overall cancer detection rate and the detected GS in patients with indicated maxPI-RADS in fusPbx and sysPbx and in the combination of both. Regarding the localization of lesions harbouring PCa ($n = 61$), 46% ($n = 28$), 28% ($n = 17$) and 26% ($n = 16$) were located in the peripheral, central and anterior zone of the prostate respectively.

Table 3. Description of changes mpMRI in patients with initial combination of fusPbx and sysPbx before initialization of active surveillance and outcome in surveillance biopsy

Number of patients	Initial MRI		MRI at time of surveillance biopsy		Criteria for progression		Progression in Gleason score	Reclassification according to PRIAS
	number of lesions	PI-RADS max	number of lesions	PI-RADS max	PI-RADS	size/number of lesion		
1	3	2	3	3	–	–	0	1
2	1	3	1	3	–	–	0	0
3	2	3	2	3	–	–	1	1
4	2	4	2	4	Yes	–	0	1
5	2	5	1	4	Yes	Yes	1	1
6	1	3	1	3	–	–	1	1
7	2	4	2	4	–	–	0	0
8	2	5	4	5	–	Yes	1	1
9	1	2	1	2	–	–	1	1
10	1	–	2	–	–	Yes	0	0
11	1	2	1	3	Yes	–	1	1
12	4	–	4	4	–	–	0	0
13	1	3	1	3	–	–	0	0
14	1	4	1	–	–	–	0	0

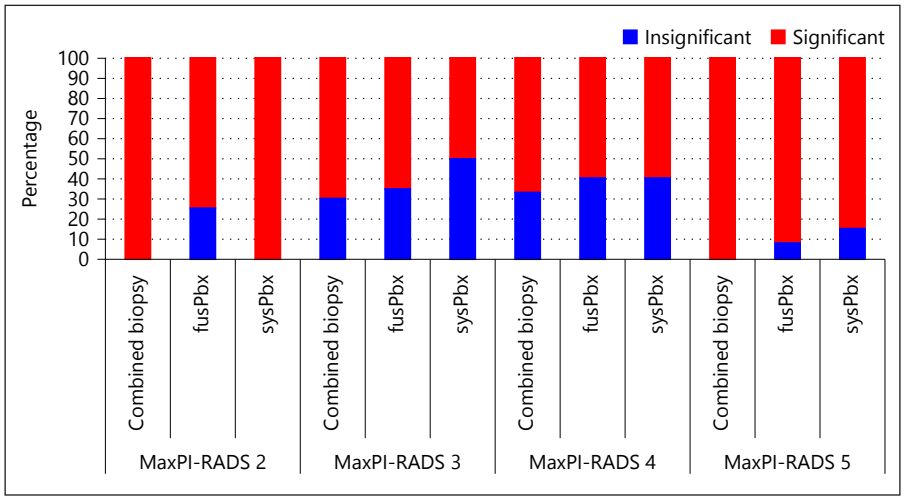

Fig. 1. Association between the detection of clinically insignificant and significant prostate cancer according to PRIAS and the maximal PI-RADS in patients with mpMRI with indicated PI-RADS (n = 52; maxPI-RADS 2: n = 4; maxPI-RADS 3: n = 20; maxPI-RADS 4: n = 15; maxPI-RADS 5: n = 13).

In uni- and multivariate analyses for the prediction of reclassification according to PRIAS criteria in surveillance biopsy, the strongest independent predictor was a high PSA-density defined as a ≥median of 0.12 ng/mL^2 (OR 4.7 95% CI 1.282–16.89; p = 0.019) adjusted to the age, median PSA-level, median prostate volume, result of the digital rectal examination and evidence of PI-RADS ≥3 and ≥4 lesions. However, the presence of at least one lesion with PI-RADS ≥4 did not predict tumour progression (OR 1.0, 95% CI 0.336–2.976; p = 1.0) in univariate analysis.

Comparison of Tumour Grading in Biopsy and Radical Prostatectomy Specimen in Patients Undergoing Radical Prostatectomy

Twenty-nine out of 59 (49%) patients reclassified according to PRIAS criteria underwent radical prostatectomy at our institution. Histopathological data of the prostatectomy specimen is depicted in Table 4. Eight out of 29 (28%) of these patients presented an unfavourable tumour stage defined as ≥pT3 and one patient (3%) presented lymph node metastasis, which was not detected in mpMRI. At staging, no patient presented distant metastasis.

Table 4. Histopathological data of patients with reclassification according to PRIAS criteria who underwent radical prostatectomy a tour institution (n = 29)

	n	%
pT-stage		
pT2a	1	3
pT2b	20	69
pT3a	6	21
pT3b	2	7
pN		
pN0	28	97
pN1	1	3
Gleason score		
6	2	7
3 + 4	18	62
4 + 3	8	28
≥8	1	3
Not described due to neoadjuvant androgen deprivation therapy	3	10

Discussion

In clinical practice, the follow-up for patients under AS is based on PSA-value, PSA-density, DRE and repeated biopsy in defined intervals according to the used AS protocol [13, 14, 19]. However, there is no consensus for AS protocols and time points of investigations including surveillance biopsies. Moreover, the definition of clinically significant PCa and tumour progression for AS patients is still heterogeneous [2].

MpMRI and consecutive targeted biopsy have shown a good accuracy in diagnosing clinically significant PCa [11, 20, 21]. Furthermore, mpMRI detects tumour-suspicious lesions with a high sensitivity [5, 8]. Additionally, tumour upgrading may be expressed by the progression of a tumour-suspicious lesion in terms of the size and grade of suspiciousness [22, 23].

In this study, we investigated patients with low-risk PCa undergoing surveillance biopsies. To the best of our knowledge, this is the first study comparing transperineal fusPbx to conventional transrectal sysPbx as surveillance biopsy in patients with low-risk PCa and to provide data of final histopathology in radical prostatectomy specimens.

Here, we show that the detection rate of tumour progression defined as upgrading to a GS ≥7 (3 + 4) tumour in fusPbx is as high as in sysPbx. In our study, the combination of both biopsy modalities outperformed each single modality regarding the detection of GS ≥7 (3 + 4; 48 vs. 39% in fusPbx, p = 0.008 and vs. 37% in sysPbx, p = 0.0012) and reclassification according to PRIAS (72 vs. 64% in fusPbx, p = 0.016 and vs. 59% in sysPbx, p = 0.001). The median number of taken cores in our cohort was 18 in comPbx, 12 in sysPbx and 6 in fusPbx. Other study groups perform fusPbx in combination with volume-based systematic template biopsy, which results in a median number of 20–30 systematic cores, while the detection rate of all and significant PCa was comparable to our detection rates in sysPbx [24–26].

Our reclassification rates according to Gleason score and to PRIAS in fusPbx and in the combination with sysPbx appear to be high compared to reported reclassification rates of 17–48% for mpMRI and targeted biopsy in the current literature [6, 11, 20, 27–29]. However, the use of different software systems for fusion biopsies and the heterogeneous definitions for tumour upgrading and reclassification might lead to this variability. Radtke et al. [11] showed that an initial fusPbx in combination with sysPbx leads to a significantly less frequent reclassification in surveillance biopsy performed by fusPbx in combination with template biopsy than sysPbx alone in the initial biopsy. Moreover, we showed that reclassified patients undergoing radical prostatectomy present an unfavourable tumour stage (≥pT3) in 28%, which is comparable to the current literature [3]. Both aspects might indicate that misclassification might occur at initial biopsy mainly performed solely by sysPbx in our cohort.

In our study, both biopsy modalities alone would miss a considerable number of significant PCa detected by the other modality (23% in fusPbx vs. 25% in sysPbx). This missing rate of significant PCa is comparable to published missing rates of up to 30% for fusPbx in confirmatory biopsy and therefore, sysPbx should not be completely replaced by exclusive fusPbx [28, 30]. Tran et al. [31] investigated 207 patients undergoing surveillance biopsy with fusPbx in combination with sysPbx. Here, 40% of patients presented a tumour upgrading, whereby 24% of them were detected on sysPbx, 14% on fusPbx and 2% on both. However, they showed that in patients with a negative mpMRI, sysPbx still resulted in a 9% upgrading to Gleason score ≥4 + 3 and concluded that sysPbx should still be offered even with prior extended sextant biopsy [31]. Other data confirm this by showing a low relative sensitivity ratio of 0.33 for the detection of Gleason score ≥7 PCa in mpMRI compared to sysPbx [32]. In contrast, other study groups demonstrated that mpMRI and targeted biopsy mainly contributed to the Gleason score upgrading, whereas sysPbx did not lead to an upgrading [33]. In

our cohort, the combination of both biopsy modalities detected a higher rate of upgrading (48%) and reclassification to clinically significant PCa (72%) compared both modalities alone.

The suspicion grade of lesions detected on mpMRI is associated with the detection rate of clinically significant PCa. In this study, we demonstrated that higher the PI-RADS, higher will be the detection rate of clinically significant PCa. However, in this cohort, the detection rate of clinically significant PCa in lesions classified as PI-RADS 2 by fusPbx is high. As we have shown in a previous study, detection rates of clinically significant PCa in PI-RADS 2 or PI-RADS 3 lesions is higher in patients undergoing surveillance biopsy within an AS protocol than in patients undergoing first or repeat biopsy [34]. In patients on AS, higher detection rates of clinically significant PCa in low-suspicious lesions might be related to a higher evidence of PCa [34]. Furthermore, in the present study, we found a relatively high detection rate of clinically significant PCa in comPbx in patients presenting a maxPI-RADS 3 compared to patients presenting a maxPI-RADS 4–5. This might be related to a high detection rate of clinically significant in sysPbx. Nassiri et al. [23] reported surveillance biopsy outcomes in patients with initial and surveillance fusPbx and showed a high rate of Gleason score upgrading of 97% in mpMRI-lesions progressing in size or grade of suspiciousness. Furthermore, it has been demonstrated that stable findings on mpMRI were associated by stable tumour grading in surveillance biopsy [35, 36]. Moreover, highly suspicious lesions detected in mpMRI were the most significant predictor of Gleason score upgrading [37]. In accordance with these data, Hu et al. [22] described a likelihood of reclassification of 24–29% in low-suspicious lesions, whereas the reclassification rate was 45 to 100% in highly suspicious lesions. Our data underline these findings, since in 50% of those presenting tumour progression to GS ≥7 (3 + 4) or reclassification in our cohort also showed progression of lesions detected in mpMRI (Table 3). However, we investigated only a small number of patients in this subgroup with initial fusion biopsy in the current study. Additionally, the localization of lesions in mpMRI may contribute to tumour upgrading and consecutive reclassification. So, in our cohort, 26% of lesions harbouring significant PCa with a GS ≥7 (3 + 4) were located in the anterior zone of the prostate, which is not easily reached by sysPbx.

Additionally, it has been reported that the combination of findings in mpMRI and clinical parameter like PSA density [38] and the use of nomograms based on these parameter might help to predict tumour upgrading to clinically significant PCa in a non-invasive approach to confirm AS [7, 29, 39]. However, this approach has to be investigated continuously especially with regard to further diagnostic and predictive biomarkers. So far, in the synopsis of our results and in the context of the current literature, mpMRI and consecutive targeted biopsy should be still combined with sysPbx to avoid missing the tumour progression and reclassification in patients under AS. However, according to available data, decisions related to whether a surveillance biopsy can be omitted at all cannot be based on MRI findings alone.

Our study has several limitations. First, we investigated a rather small number of patients with low-risk PCa undergoing surveillance biopsy. Therefore, the difference in the detection rates in fusPbx compared to sysPbx might be higher with a higher number of included patients. Second, initial biopsy was not performed in all patients with solely sysPbx. In initial biopsy, 17% of patients underwent fusPbx combined with sysPbx. This heterogeneous patient cohort might lead to an overestimation of the accuracy in initial biopsy. However, in this cohort, this subgroup with initial fusion biopsy did not show a lower rate of reclassification.

Third, we did not acquire data about further treatment in all patients with proven tumour progression, so that our results of final histopathology gained by radical prostatectomy should be interpreted with caution.

Next, fusPbx and sysPbx were performed subsequently by the same urologist and hence he was unblinded. Systematic cores were placed according to a pre-defined scheme. There was no additional software-based documentation that would allow the retrospective analysis of systematic cores. Consequently, the knowledge about the location of lesions in mpMRI could have influenced the operator in needle placement unwittingly during sysPbx. This could have resulted in a falsely high detection rate in sysPbx. Another limitation is that PI-RADS was not applied in all patients. However, detection rates of any and clinically significant cancer in the subgroup analysis including only patients with reported PI-RADS showed similar results compared to the whole cohort. Finally, we did not perform a standardized long-term follow-up assessment to detect false-negative cases.

Conclusions

The combination of fusPbx and sysPbx outperforms both modalities alone with regard to the detection of tumour upgrading and reclassification in patients with low-risk PCa under AS.

Thus, mpMRI and targeted fusPbx in combination with sysPbx should be offered to patients undergoing control-biopsy for low-risk PCa in an AS protocol. However, due to a still high missing rate of significant PCa in fusPbx alone, sysPbx should not be omitted at this point. Finally, according to our data, control biopsies during AS cannot be replaced by MRI alone.

Disclosure Statement

There are no conflicts of interest for the authors to disclose.

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